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TECHNICAL REPORT 3576



**A TEST TO DETERMINE THE CAUSE
OF
BARREL EROSION
IN THE
40 MM M75 LAUNCHER**

DELBERT B. DECKER

JUNE 1967

**PICATINNY ARSENAL
DOVER, NEW JERSEY**

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PICATINNY ARSENAL
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ACKNOWLEDGMENT

The Process Engineering Laboratory, Ammunition Engineering Directorate, of Picatinny Arsenal developed the talc additive for the propellant systems to reduce gun barrel wear.

SUMMARY

This study by the Ammunition Engineering Directorate's Applications Engineering Laboratory was to determine the effect on the 40mm M75 Gun barrel wear using four different cartridge case systems (using the M169 Cartridge Case series).

The M75 Gun is part of the M5 Weapon System for Helicopters.

CONCLUSIONS

Test results indicated that both the cartridge with talc additive and a single-chamber case produced minimal barrel wear. All other systems tested produced excessive wear and reduced M75 Gun barrel life.

RECOMMENDATIONS

On the basis of the test results the present two-piece cartridge should be replaced with a single-chamber cartridge case. Although the two-piece cartridge case with talc additive produces results comparable with the single chamber, use of the single-chamber case would result in substantial cost savings in materiel and labor as well as eliminating a source of system malfunctioning.

HISTORY

Background

Reports of excessive M75 Gun barrel wear with attendant short barrel life and diminished effectiveness of the round led to an investigation from April-October 1966 to determine the cause of the wear and to determine corrective measures. During the development of the present two-piece highlow case, excessive erosion of the flash holes was observed, accompanied by a large standard deviation of velocity as well as diminished velocity. It was felt that the by-products of the erosion of the flash holes contributed to the excessive barrel wear; a study was made to find an additive that would counteract this condition. The results indicated that 100 milligrams of talc enclosed in a polyethylene packet and placed in the bottom of the propellant chamber might be the solution.

Malfunctions

Parallel to the condition of erosion was another problem: the crimping of the base plug in the two-piece case. Failure of the crimp resulted in a leakage of pressure causing the weapon to jam and could also result in a hangfire. In either case, this would abort the mission and could expose personnel to damaging or fatal counterfire. A change in design from a two-piece case to a one-piece case was considered the answer. As an added benefit a one-piece round would reduce cost -- both in hardware cost and assembly cost. (Figure 1 compares the two cases.) The one-piece case would eliminate the base plug crimping problem, and might solve the barrel erosion problem since there are no flash holes to erode or otherwise contribute to erosion. Therefore, it was decided to run tests concurrently on both case designs. It was also decided to run a test using a cartridge case with flash holes drilled parallel to the axis of the case since there was some belief that the angle of the flash holes directed the hot propellant gases, eroded aluminum, aluminum oxide and copper particles against the sides of the barrel -- causing barrel erosion.

TESTING PROGRAM

Test rounds were loaded at Picatinny Arsenal and test-fired at Springfield Armory, Massachusetts from April-October 1966.

Some 5,000 rounds were fired of each of the four types of cartridges, using a new production barrel for each type. A fifth test was run using the two-piece standard production case fired through a barrel fabricated from a special steel.

These four different cartridge case systems -- using the M169 Cartridge Case series -- consisted of:

1. A two-piece cartridge case (high/low pressure chamber) used in current production, M169 Cartridge Case, Part No. 8886327, Revision G, Lot PA 287-12.
2. A two-piece cartridge case with 100 milligrams of talc in the propellant chamber, M169 Cartridge Case, Part No. 8886327, Revision H, Lot PAE 54225.
3. A single-chamber cartridge case, M169E1 Cartridge Case, Part No. 9207609, Revision A, Lot PAE 54221 and 54226.
4. A two-piece cartridge case with flash holes drilled parallel with the axis of the case the same as that in current production except that the angle of holes changed, M169 Cartridge Case modified, Part No. 8886327, Lot No. PAE 54889.

Test Procedures

These test procedures were established and supervised by Springfield Armory:

1. Fire 150 rounds in 25-round bursts with one-minute delay between bursts.
2. Air-cool barrel to ambient temperature.
3. Repeat Step 1 and 2 until 600 rounds have been fired.
4. Magna-glo barrel and examine visually for wear.
5. Repeat Steps 1-4 until 1,800 rounds have been fired.

6. Photograph interior of barrel.
7. Repeat Steps 1-6, photographing the barrel at 3,600 rounds and at the completion of the test.

RESULTS

1. M385 Cartridge with the two-piece (highlow pressure) M169 Cartridge Case.

Barrel No. A-73-4147H Steel, Chrome-Plated

<u>Rounds Fired</u>	<u>Photograph</u>	<u>Remarks</u>
1,000	3	Chrome plating starting to peel off
1,765	4	No change
3,490	5	Lands eroding, chrome plating peeling
5,001	6	Severe erosion

2. M385E1 Cartridge with single chamber M169 Cartridge Case.

Barrel No. X-1, Chrome, Moly Vanadium Steel

<u>Rounds Fired</u>	<u>Photograph</u>	<u>Remarks</u>
None	7	---
1,845	8	No visible wear
3,675	9	No visible wear
5,045	10	Slight wear
5,394	11	Slight wear

3. M385 Cartridge with M169 Cartridge Case and 100 milligrams in propellant chamber. X

Barrel No. A-72, 4147 Steel, Chrome-Plated \

<u>Rounds Fired</u>	<u>Photographs</u>	<u>Remarks</u>
None	12	New Barrel
1,805	13	No visible wear
3,598	14	No visible wear
5,020	15	No visible wear
5,319	16	No visible wear

4. M385E1 Cartridge with single-chamber M169E1 Cartridge Case

Barrel No 1, 4147 Steel, Chrome-Plated

<u>Rounds Fired</u>	<u>Photograph</u>	<u>Remarks</u>
None	17	New Barrel
1,811	18	No visible wear
3,607	19	No visible wear
5,012	20	No visible wear
5,312	21	No visible wear

5. M385 Cartridge, with modified (stright holes) M169 Cartridge Case

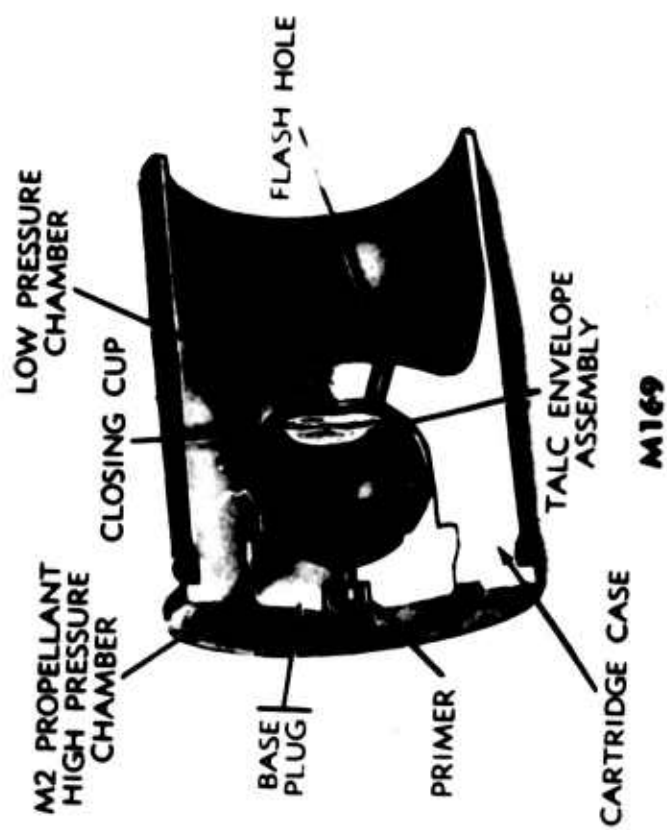
Barrel No. A-58, 4147 Steel, Chrome-Plated

<u>Rounds Fired</u>	<u>Photograph</u>	<u>Remarks</u>
20	22	New Barrel
1,800	23	Chrome Plating starting to peel. Erosion starting on lands.
3,613	24	Lands eroding -- plating peeling
4,760	25	Barrel severely eroded

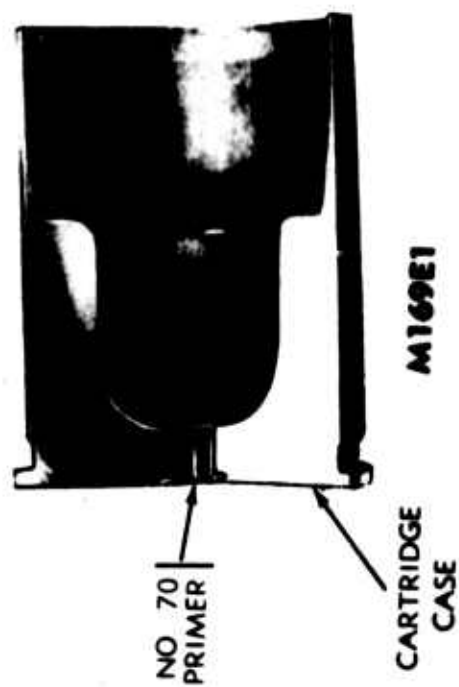
APPENDICES

APPENDIX A

Photographs

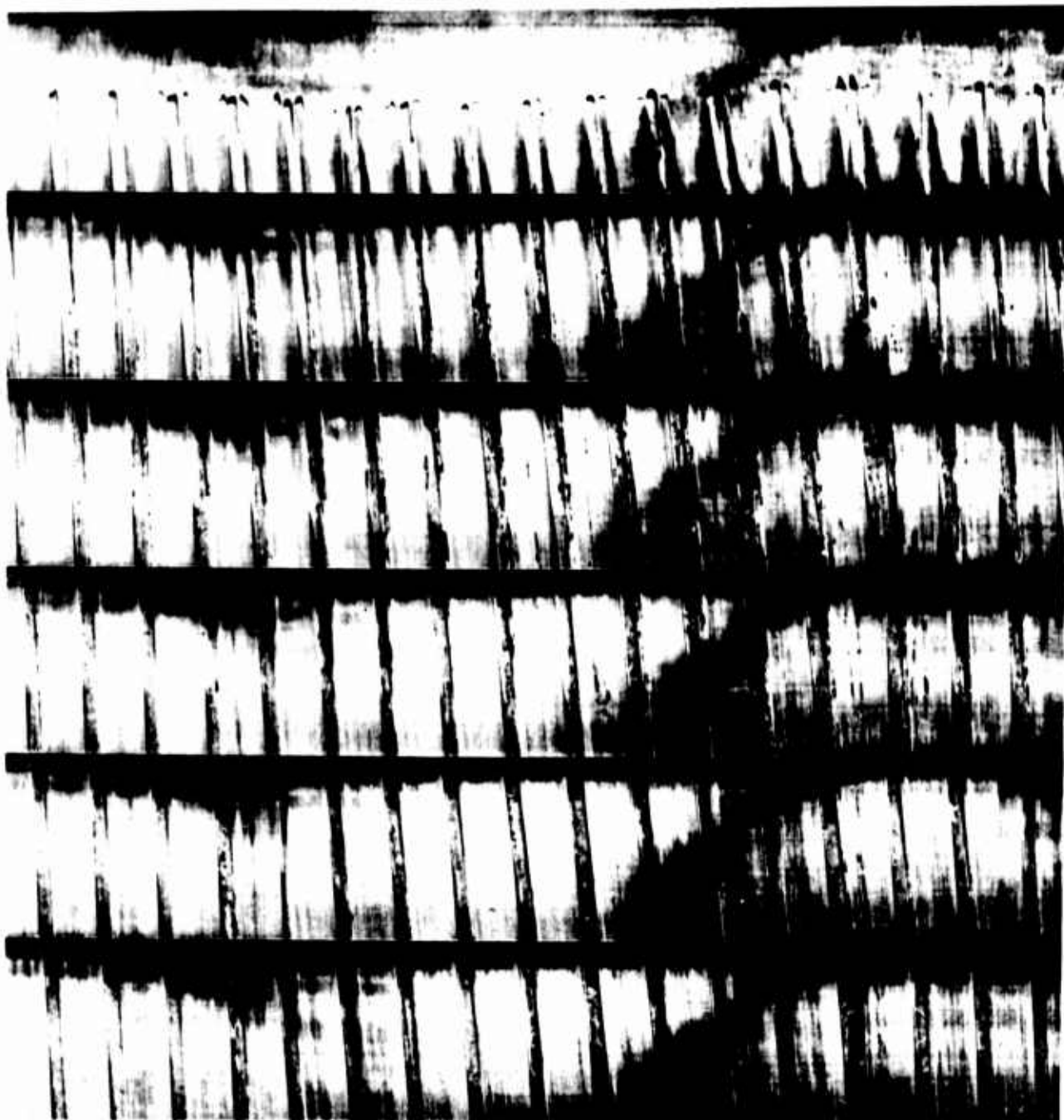


PHOTOGRAPH 1



PHOTOGRAPH 2

ORD L1714



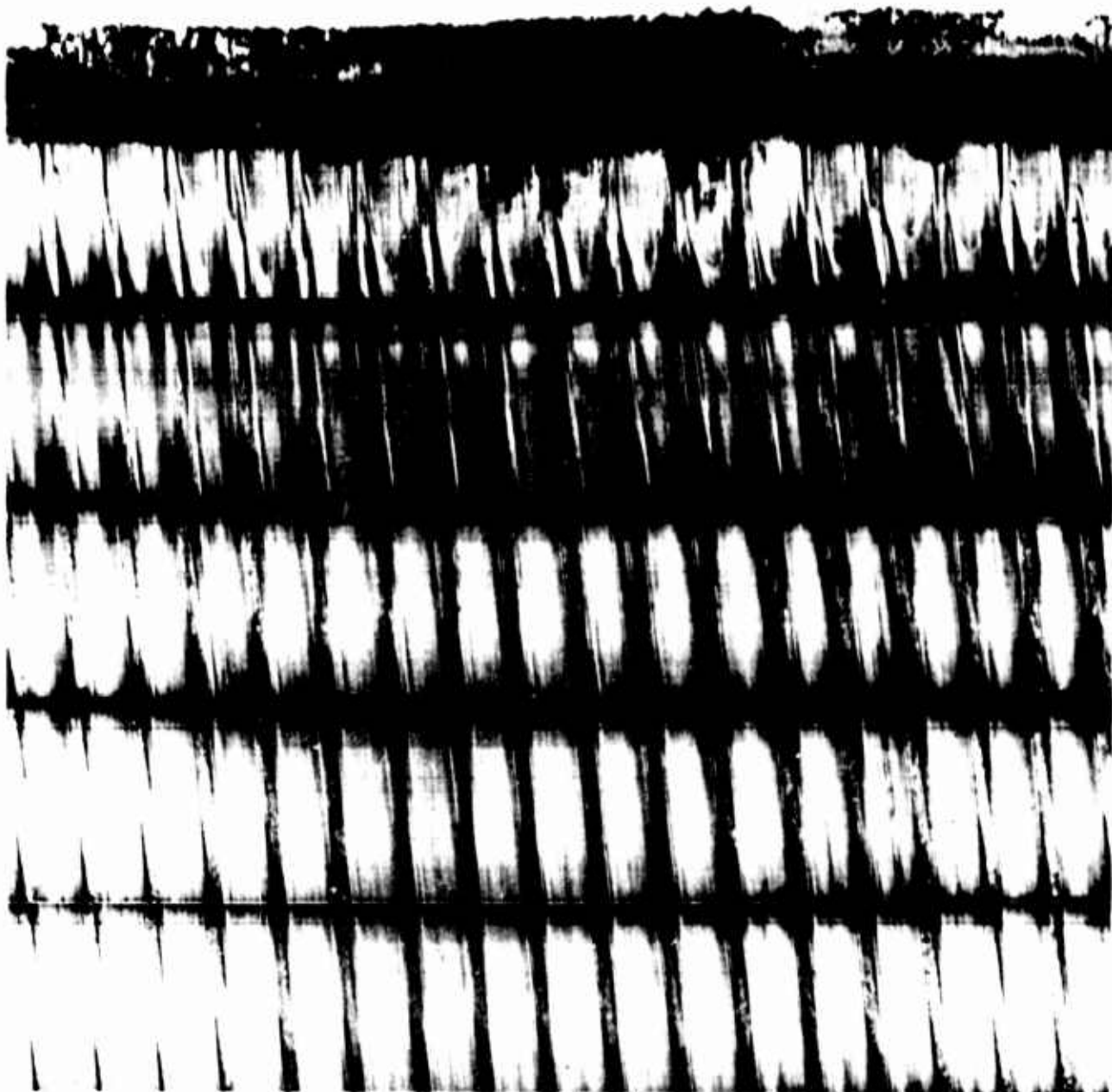
19-058-443/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

29 Apr 66

Boreoscope photo of 40mm M75 Barrel #A-73 (4148 steel) after firing 1000 rds (std M385 ammo) in 25 rd bursts with cooling at 150 rd increments.

PHOTOGRAPH 3



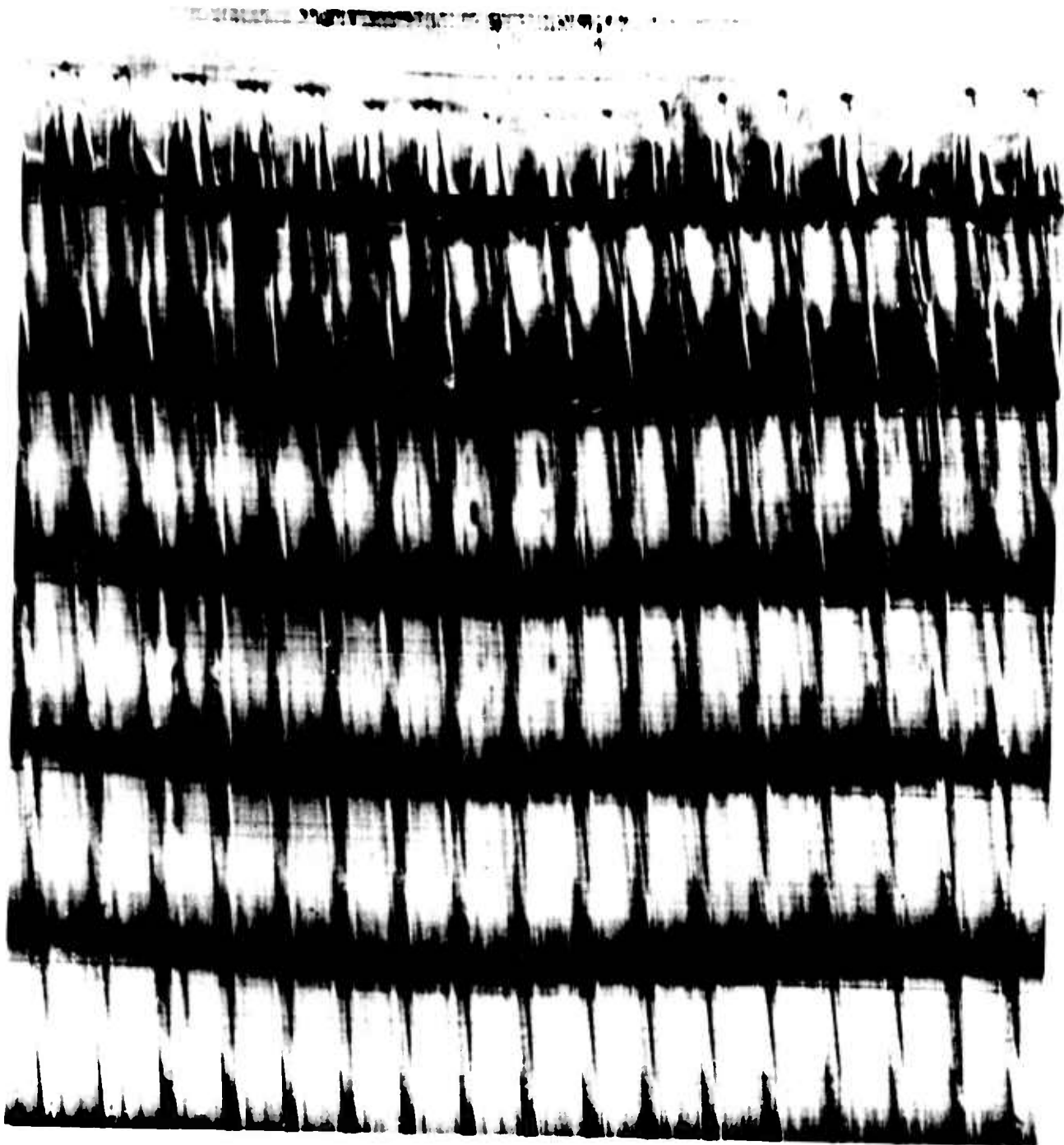
19-058-447/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

29 Apr 66

Borescope photo of 40mm M75 Barrel #A-73 (4148 steel) after firing 1765 rds (std M385 ammo) in 25 rd bursts with cooling at 150 rd increments.

PHOTOGRAPH 4

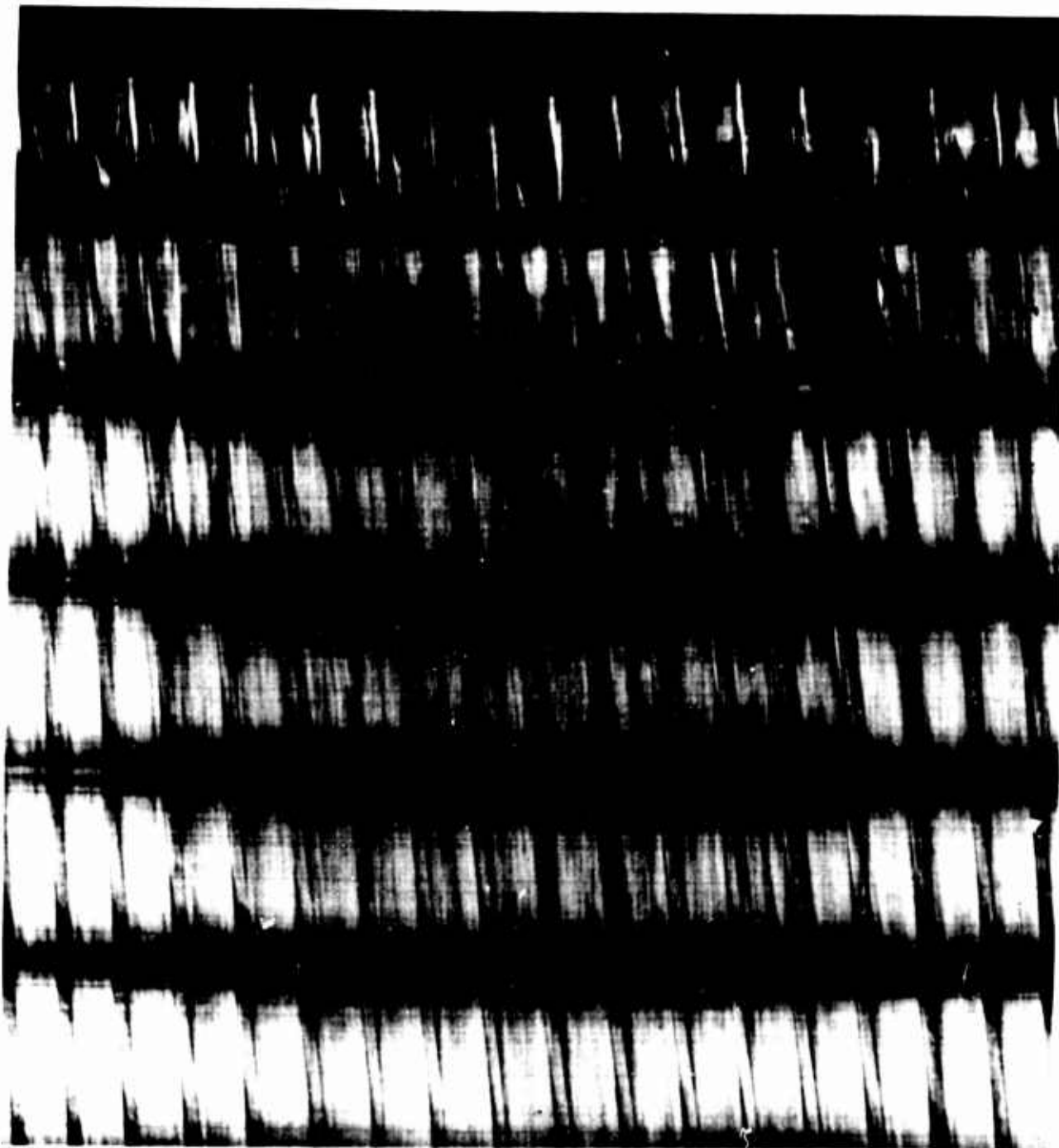


19-058-451/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

29 Apr 66

Borescope photo of 40mm M75 Barrel #A-73 (4148 steel) after firing 3490 rds
(std M385 ammo) in 25 rd bursts with cooling at 150 rd increments.



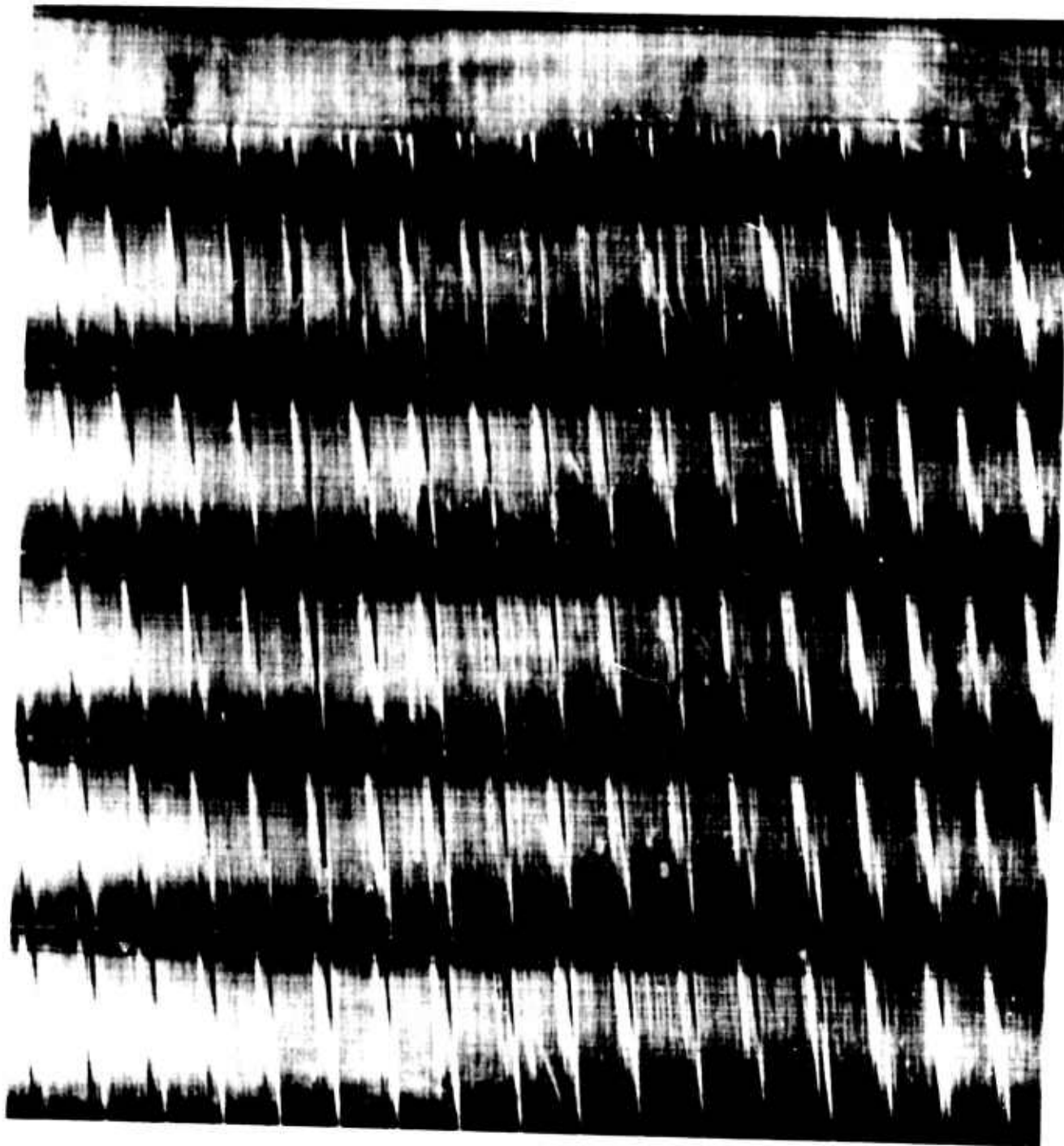
19-058-454/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

29 Apr 66

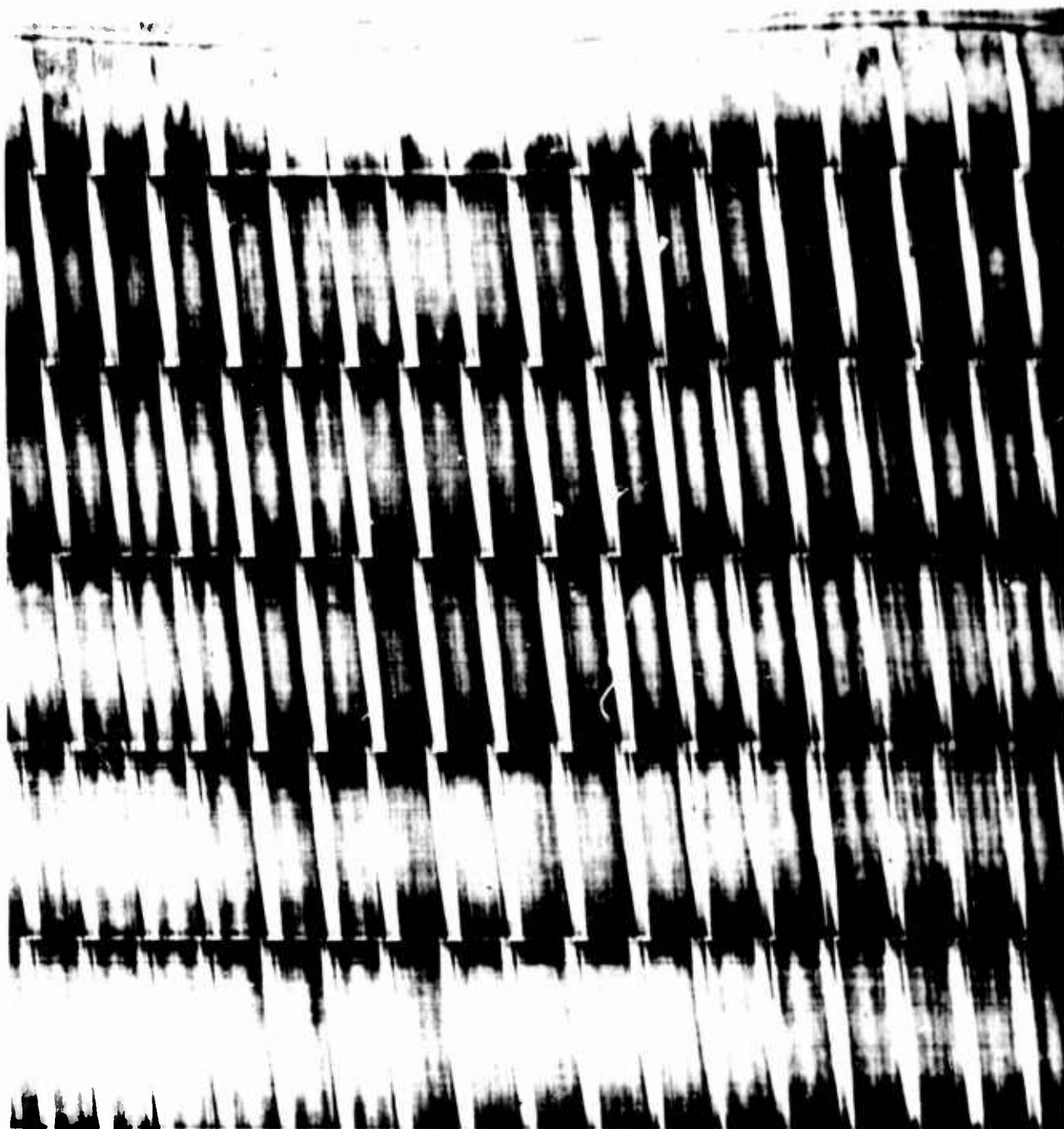
Borescope photo of 40mm M75 Barrel #A-73 (4148 steel) after firing 5000 rds (std M385 ammo) in 25 rd bursts with cooling at 150 rd increments.

PHOTOGRAPH 6



19-058-539/AMC-66 U.S. ARMY - SPRINGFIELD ARMORY 18 May 66

Borescope Photo of a Chrome - Moly - Vanadium 40mm M75 Weapon barrel
(No X1) in the unfired condition.



19-058-540/AMC-66

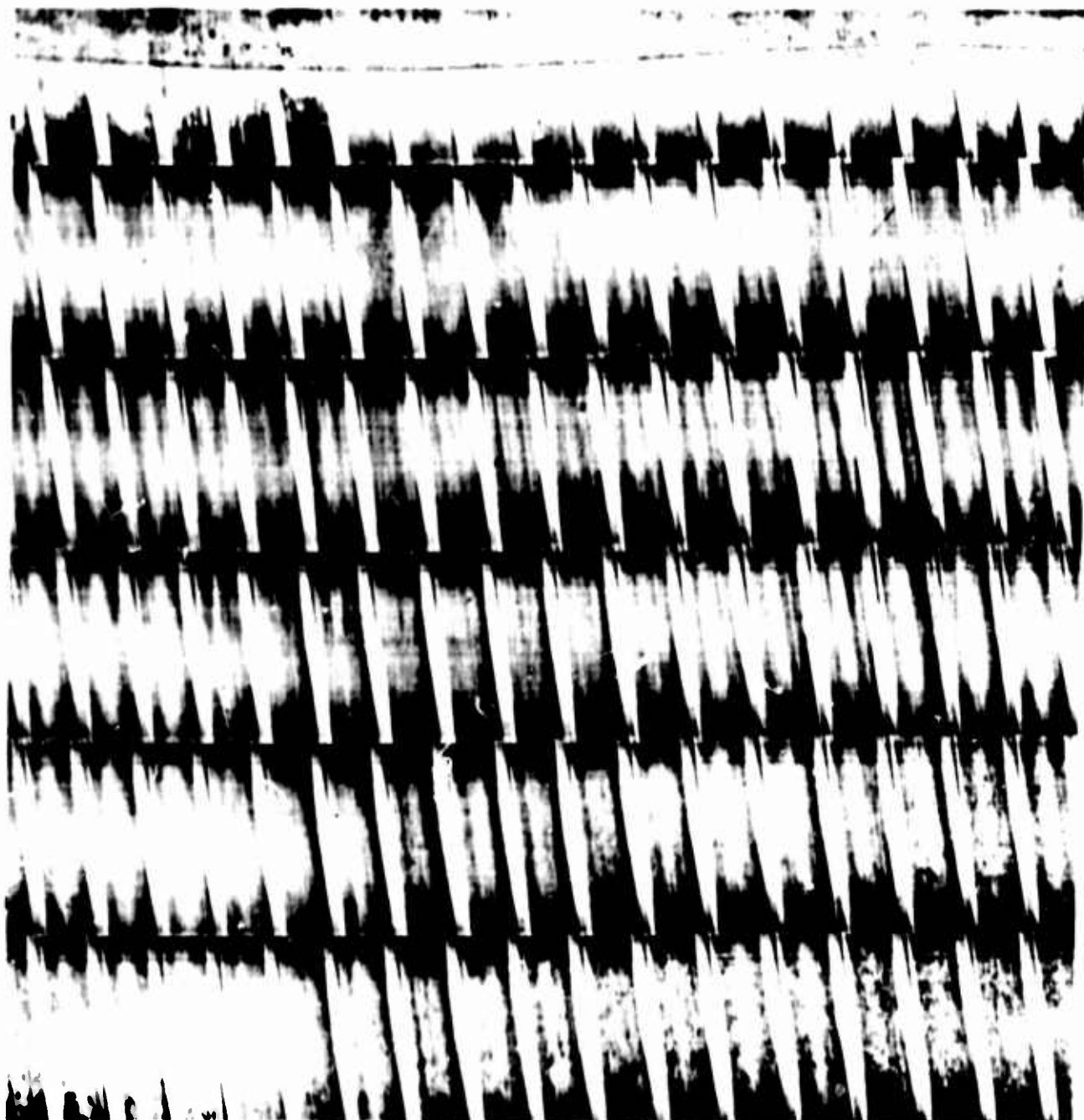
U.S. ARMY - SPRINGFIELD ARMORY

18 May 66

Borescope Photo of a Chrome - Moly - Vanadium 40mm M75 Weapon barrel
(No X1) after firing 1845 rounds (25 rd bursts w/cooling after each 150 rds.)
Ammo M385E1 single chamber.

PHOTOGRAPH 8

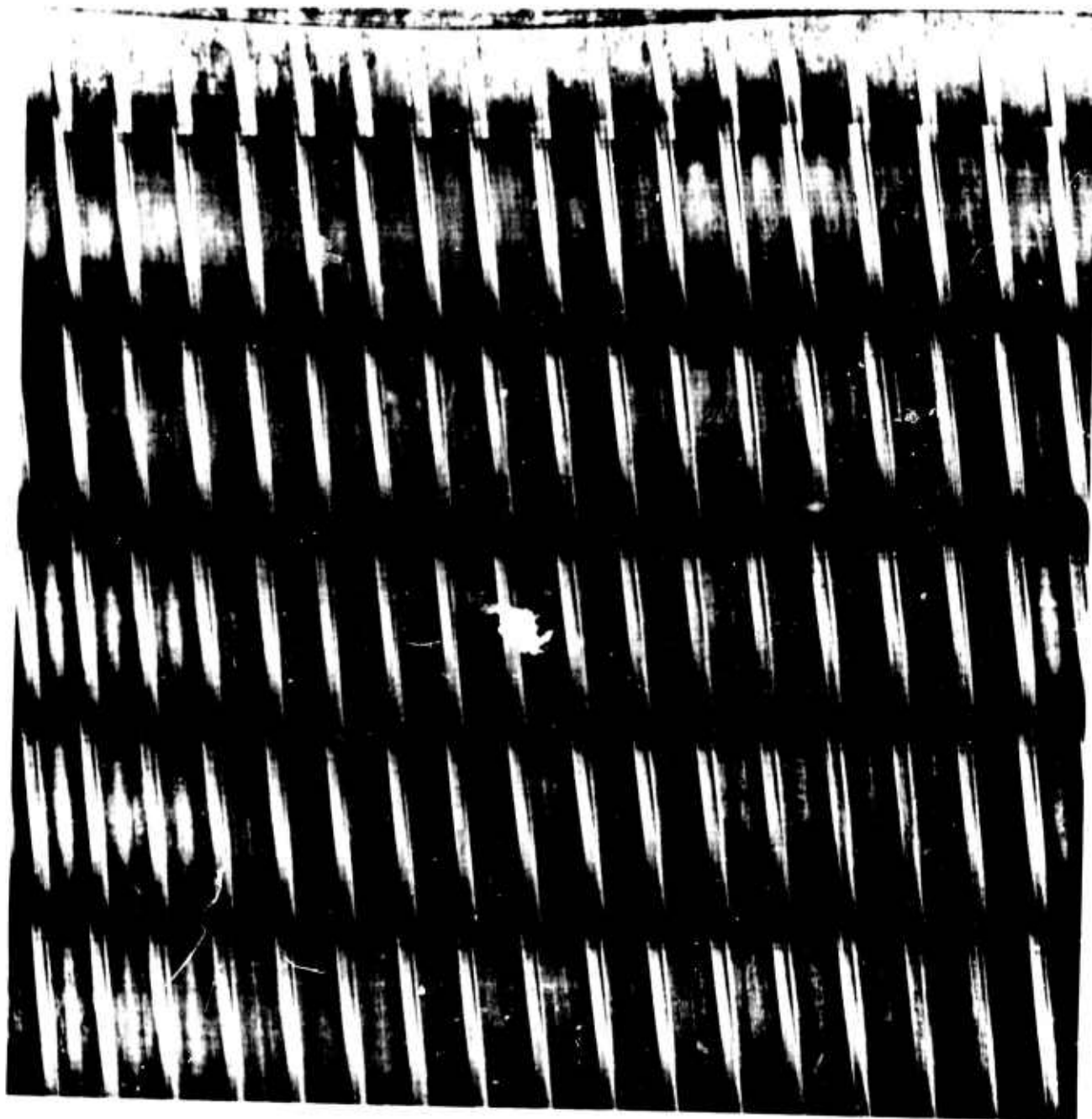
17



19-058-541/AMC-66 U.S. ARMY - SPRINGFIELD ARMORY 18 May 66

Borescope Photo of a Chrome - Moly - Vanadium 40mm M75 Weapon barrel
(No X1) after firing 3675 rds (25 rd bursts w/cooling after each 150 rds).
Ammo M385E1 single chamber.

PHOTOGRAPH 9



19-058-542/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

18 May 66

Borescope Photo of a Chrome - Moly - Vanadium 40mm M75 Weapon barrel
(No X1) after firing 5045 rds (25 rd bursts w/cooling after each 150 rds).
Ammo M385E1 single chamber.

PHOTOGRAPH 10



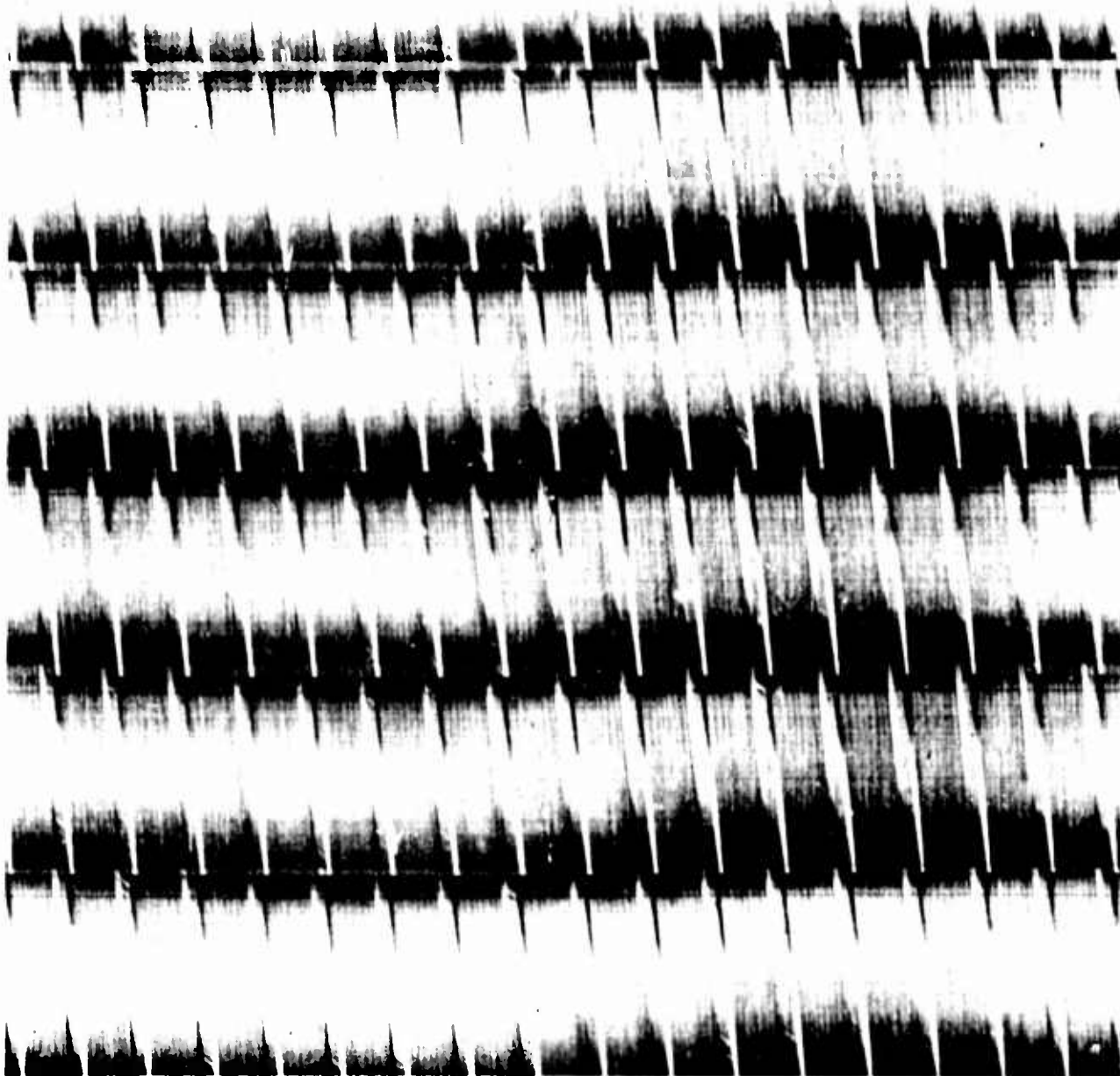
19-058-543/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

18 May 66

Borescope Photo of a Chrome - Moly - Vanadium 40mm M75 Weapon barrel (No X1) after firing 5394 rds (25 rd bursts w/cooling after each 150 rds and one 300 rd continuous burst). Ammo M385E1 single chamber.

PHOTOGRAPH 11



19-058-616/AMC-66 U.S. ARMY - SPRINGFIELD ARMORY 14 June 66

Borescope photograph of 40mm M75 Barrel #A-72 (4147 steel) before undergoing endurance firing test (new condition).

PHOTOGRAPH 12



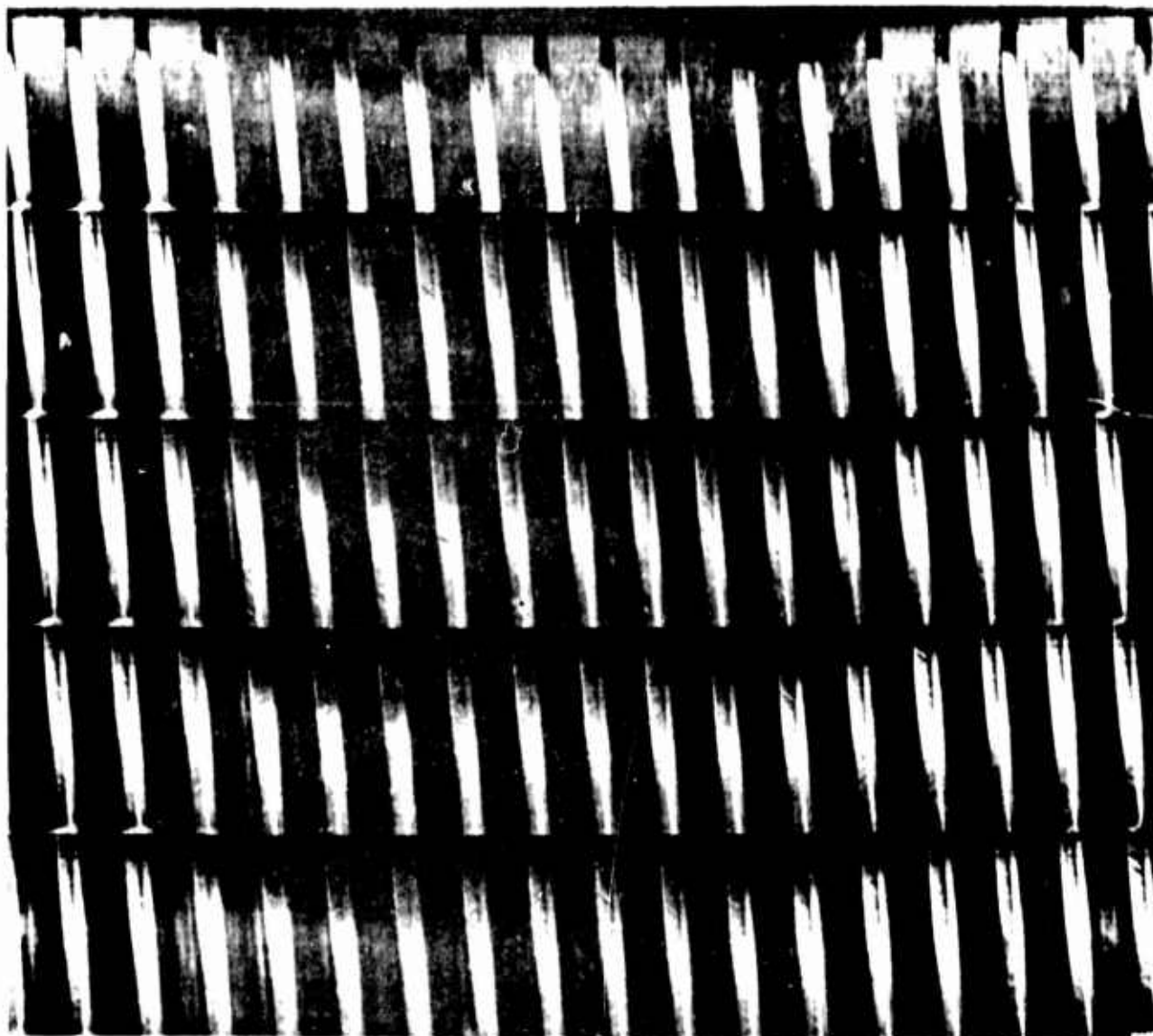
19-058-617/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

14 June 66

Borescope photograph of 40mm M75 Barrel #A-72 (4147 steel) after firing 1805 rds of M385 ammunition (tale added to propellant). Firing schedule 25 round bursts with cooling at 150 round increments.

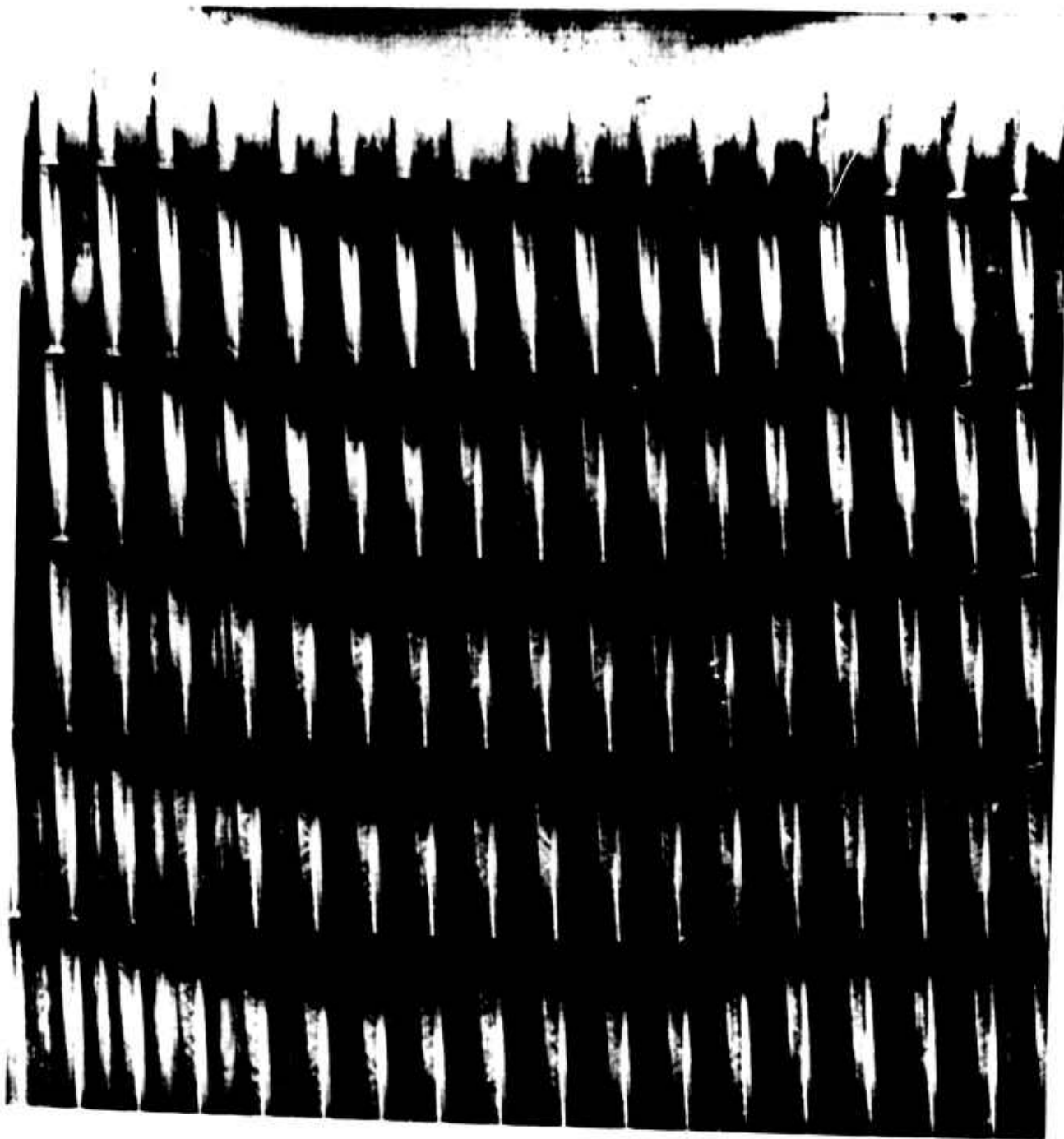
PHOTOGRAPH 13



19-058-618/AMC-66 U.S. ARMY - SPRINGFIELD ARMORY 14 June 66

Borescope photograph of 40mm M75 Barrel #A-72 (4147 steel) after firing 3598 rds of M385 ammunition (tale added to propellant). Firing schedule 25 round bursts with cooling at 150 round increments.

PHOTOGRAPH 14



1D-058-625/AMC-66

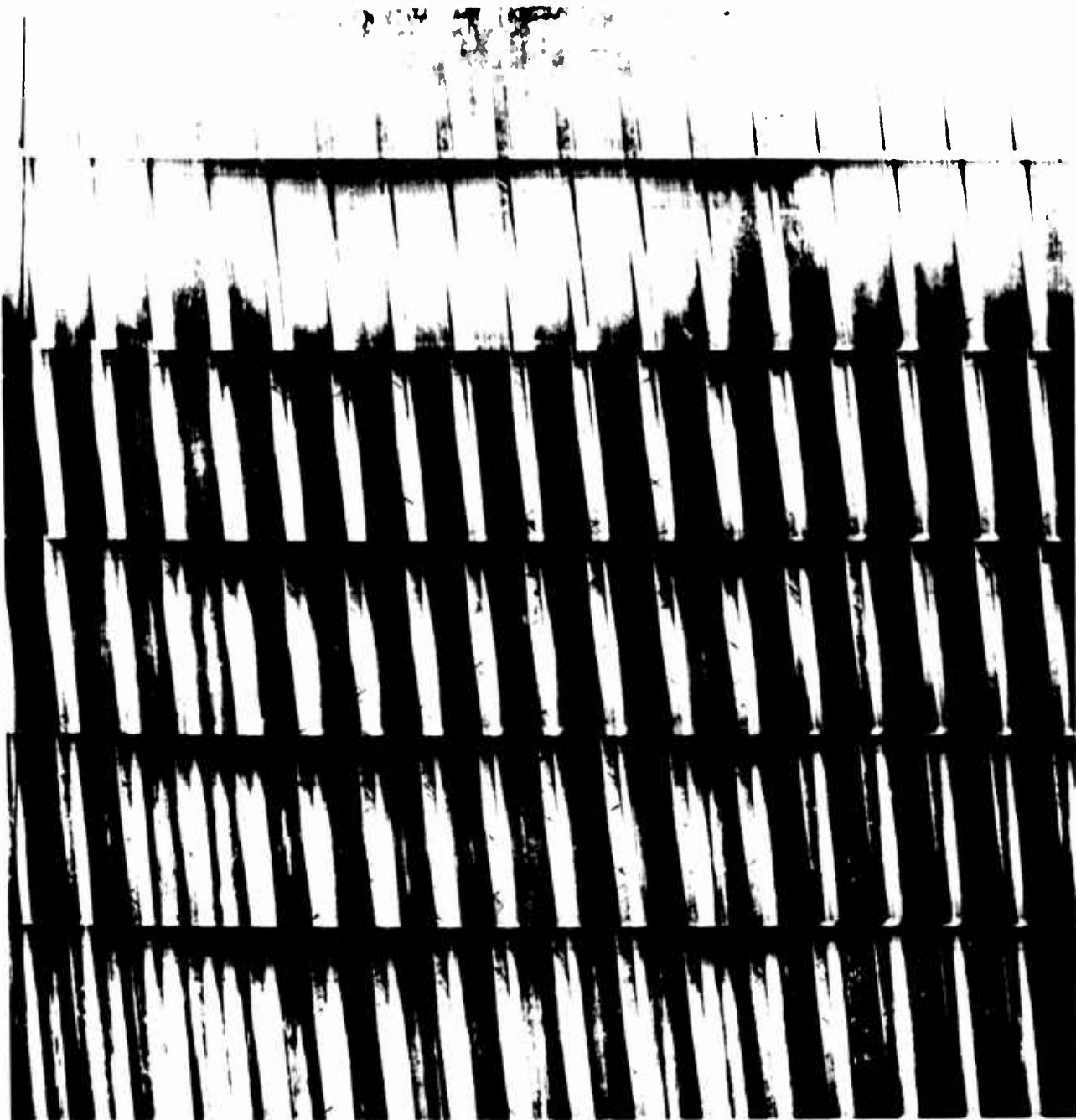
U.S. ARMY - SPRINGFIELD ARMORY

14 June 66

Boreoscope photograph of 40mm M75 Barrel #A-72 (4147 steel) after firing
5020 rds of M385 ammunition (tale added to propellant). Firing schedule
25 round bursts with cooling at 150 round increments.

24

PHOTOGRAPH 15



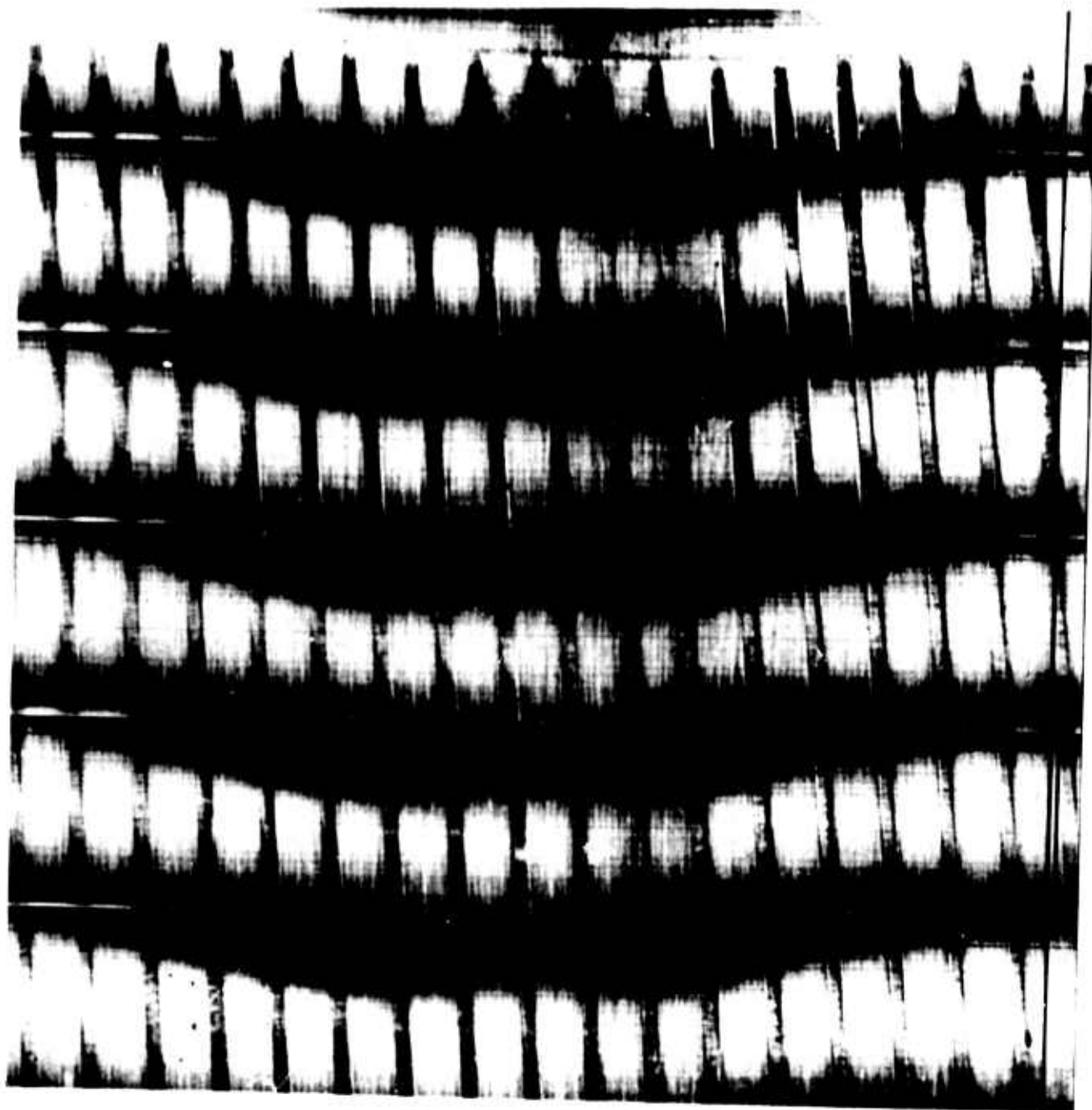
19-058-638/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

16 June 66

Borescope photograph of 40mm M75 Barrel #A-72 (4147 steel) after firing 5020 rounds of M385 ammunition (tale added to propellant) in 25 round bursts with cooling at 150 round increments followed by a sustained burst of 299 rounds.

PHOTOGRAPH 16



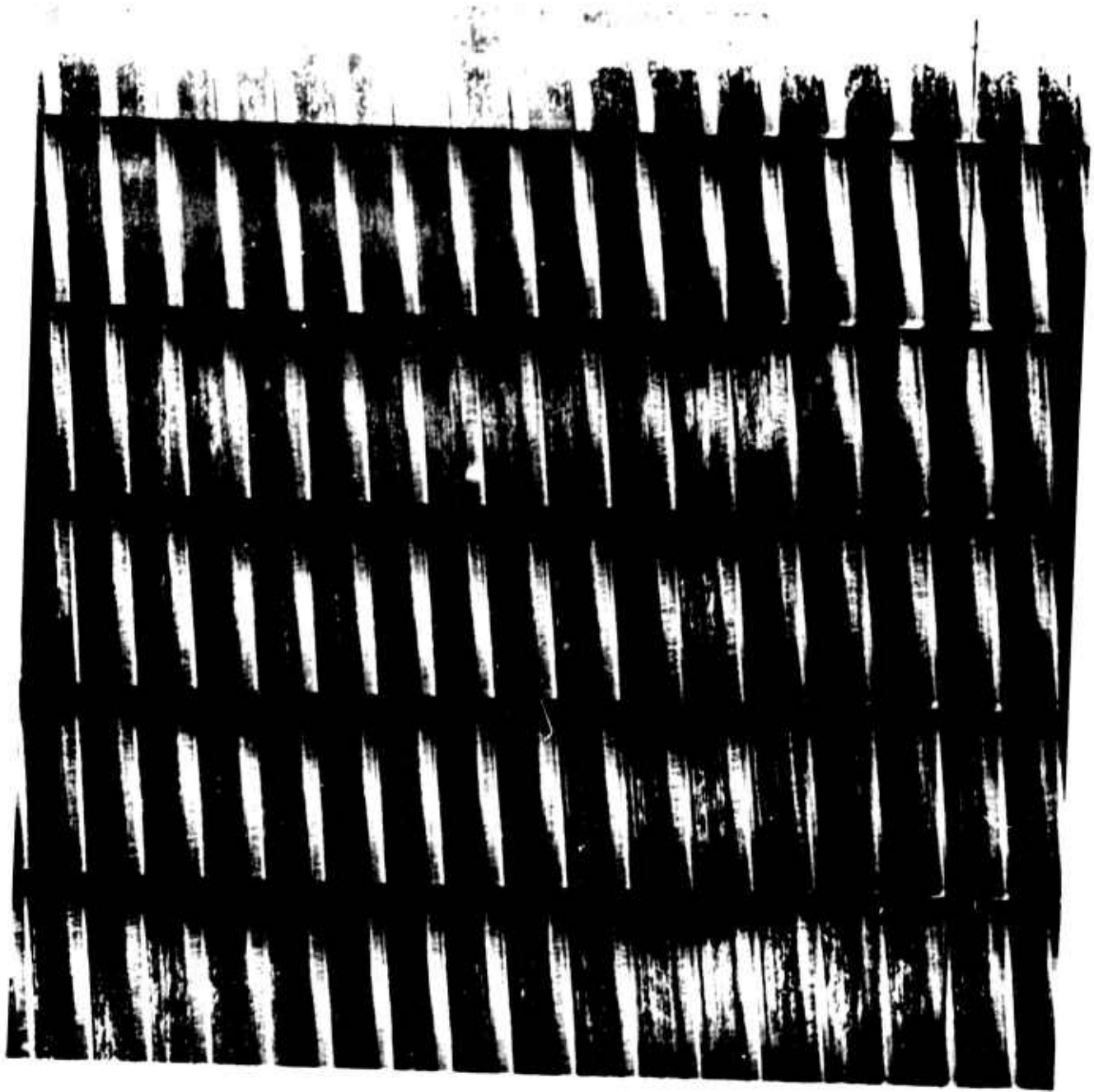
19-058-633/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

16 June 66

Borescope photograph of 40mm M75 Barrel #1 (4147 steel) before undergoing endurance firing test (new condition).

PHOTOGRAPH 17



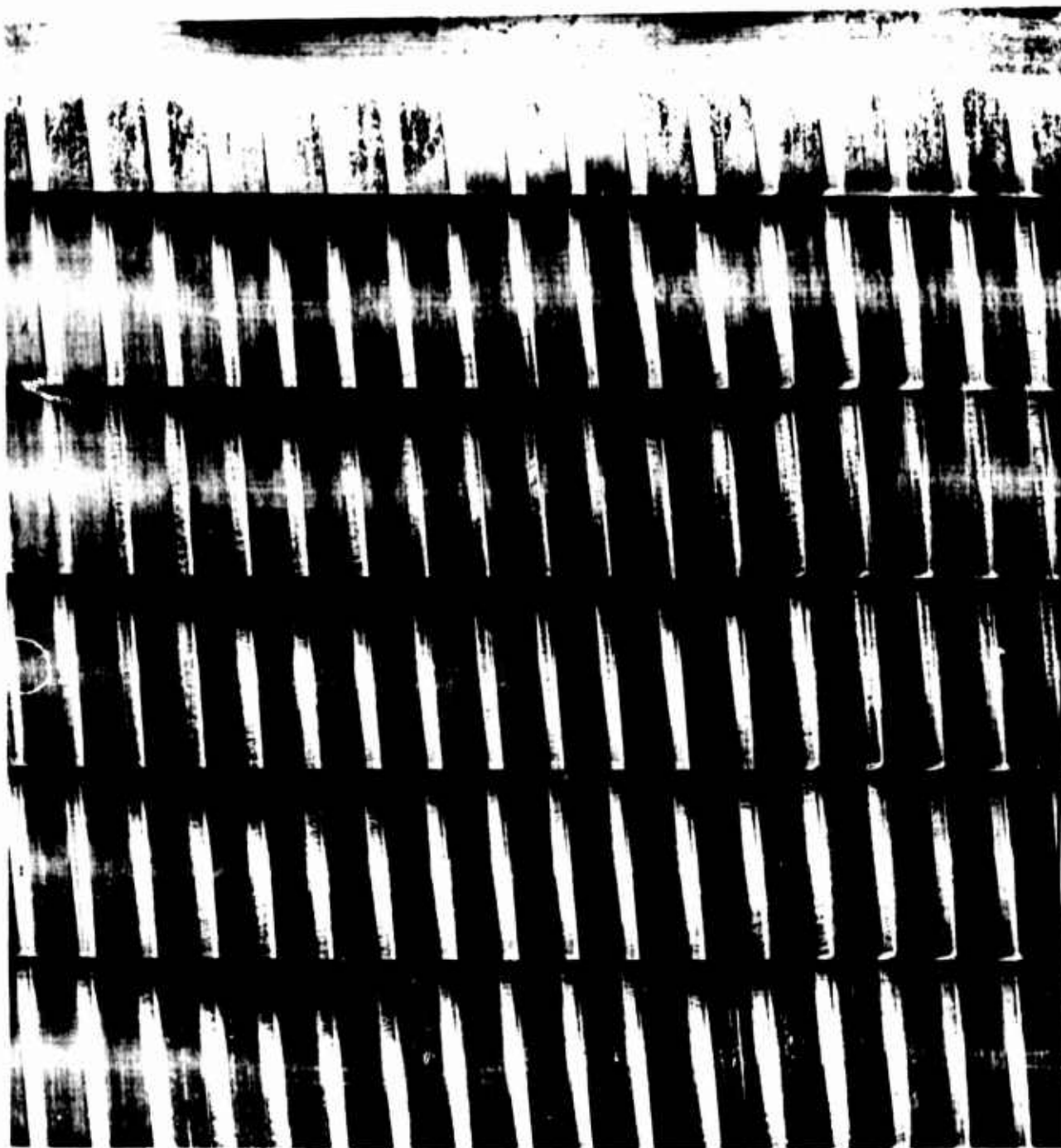
19-058-630/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

16 June 66

Borescope photograph of 40mm M75 Barrel #1 (4147 steel) after firing 1811 rounds of M385E1 ammunition (single chamber) in 25 round bursts with cooling at 150 round increments.

PHOTOGRAPH 18



19-058-631/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

16 June 66

Borecope photograph of 40mm M75 Barrel #1 (4147 steel) after firing 3607 rounds of M385E1 ammunition (single chamber) in 25 round bursts with cooling at 150 round increments.

PHOTOGRAPH 19



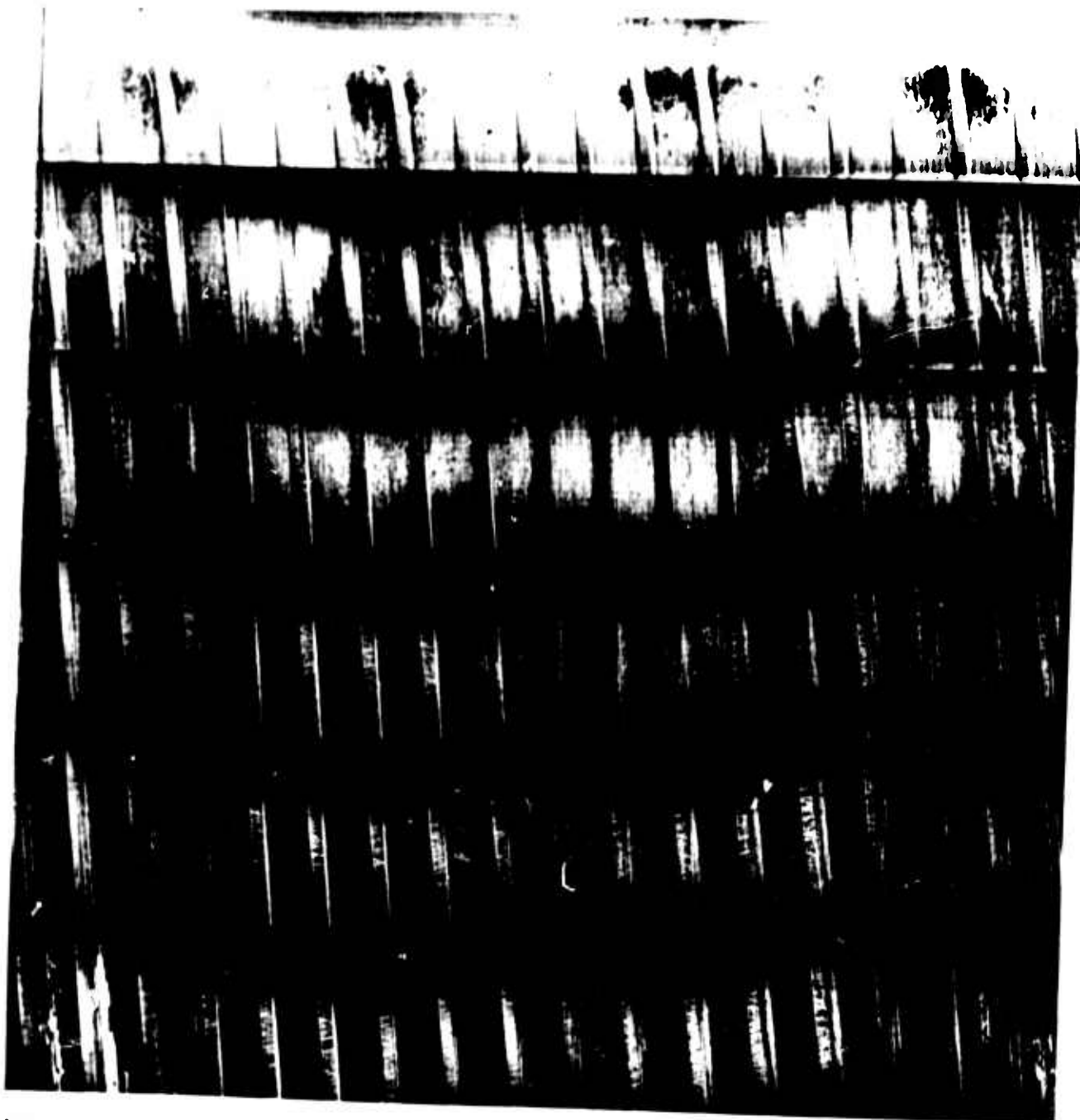
19-058-632/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

16 June 66

Borescope photograph of 40mm M75 Barrel #1 (4147 steel) after firing 5012 rounds of M385E1 ammunition (single chamber) in 25 round bursts with cooling at 150 round increments.

PHOTOGRAPH 20



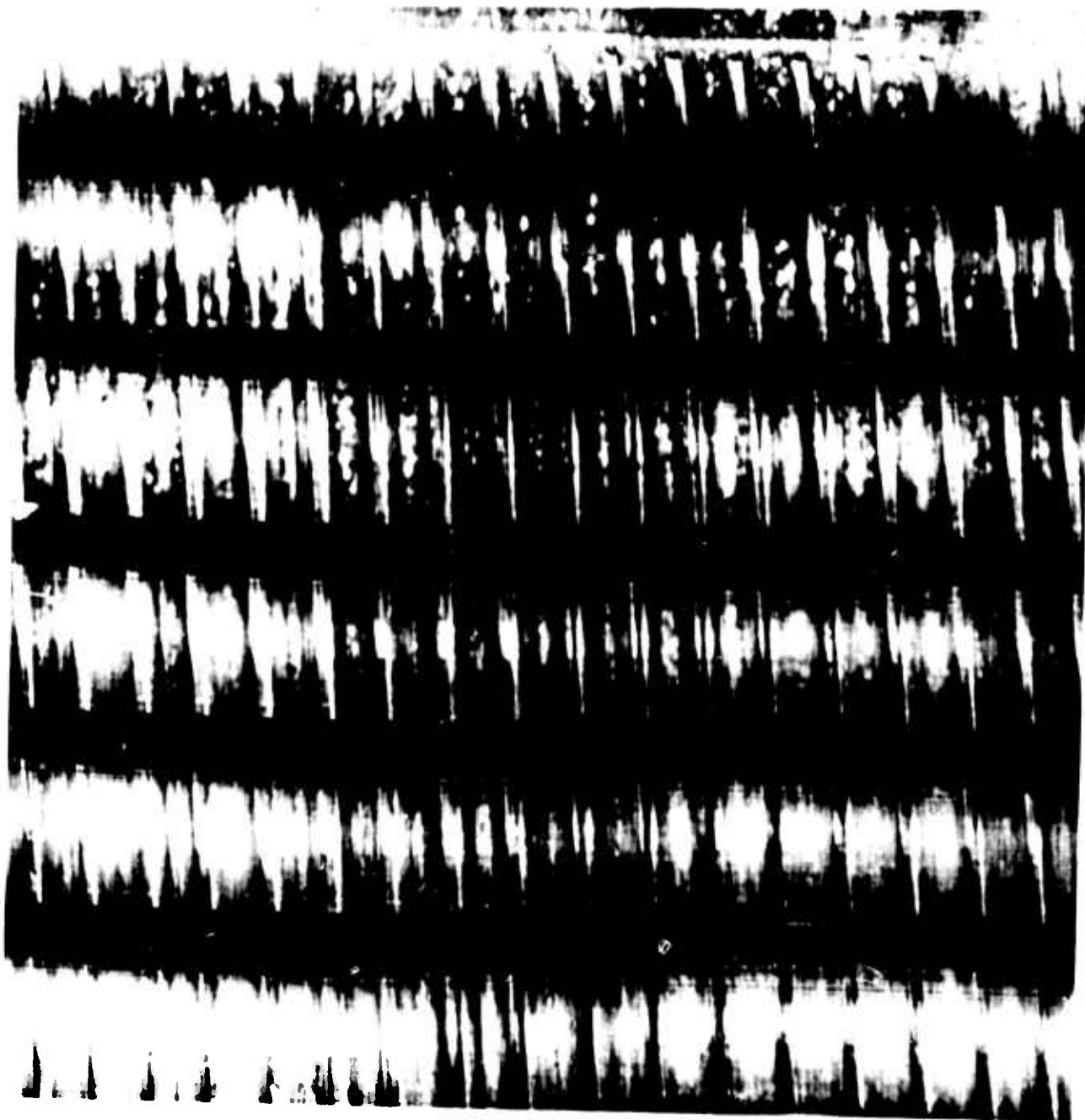
19-058-637/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

16 June 66

Boreoscope photograph of 40mm M75 Barrel #1 (4147 steel) after firing 5012 rounds of M385E1 ammunition (single chamber) in 25 round bursts with cooling at 150 round increments followed by a sustained burst of 300 rounds.

PHOTOGRAPH 21



19-058-1086/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

21 Dec 66

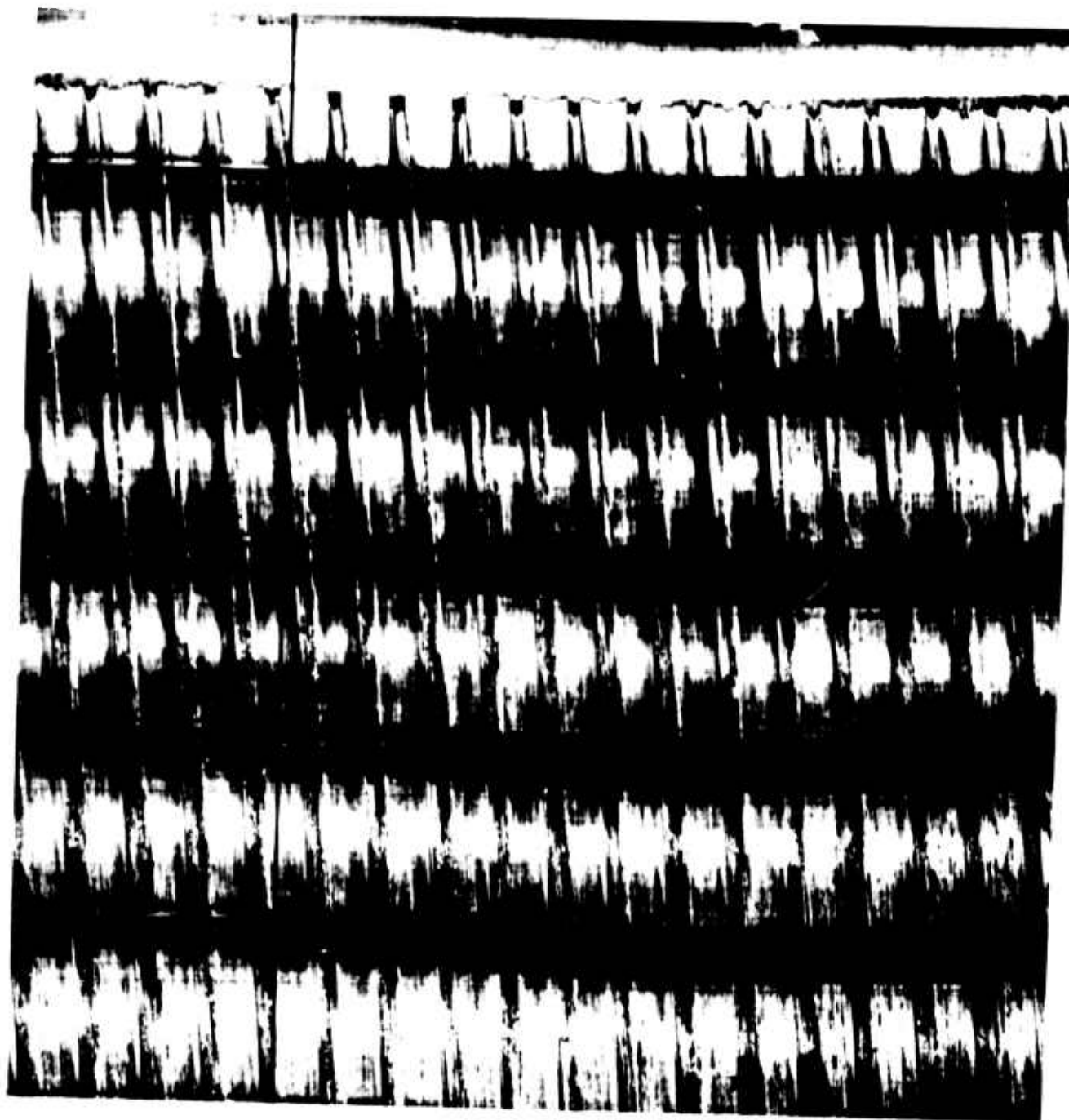
Standard M75 #F7791730 Ser #A58

Special Ammo: 40mm M385 (with orifice holes parallel to horizontal axis)

Lot PAE 54889

20 rds fired

PHOTOGRAPH 22



19-058-1087/AMC-66

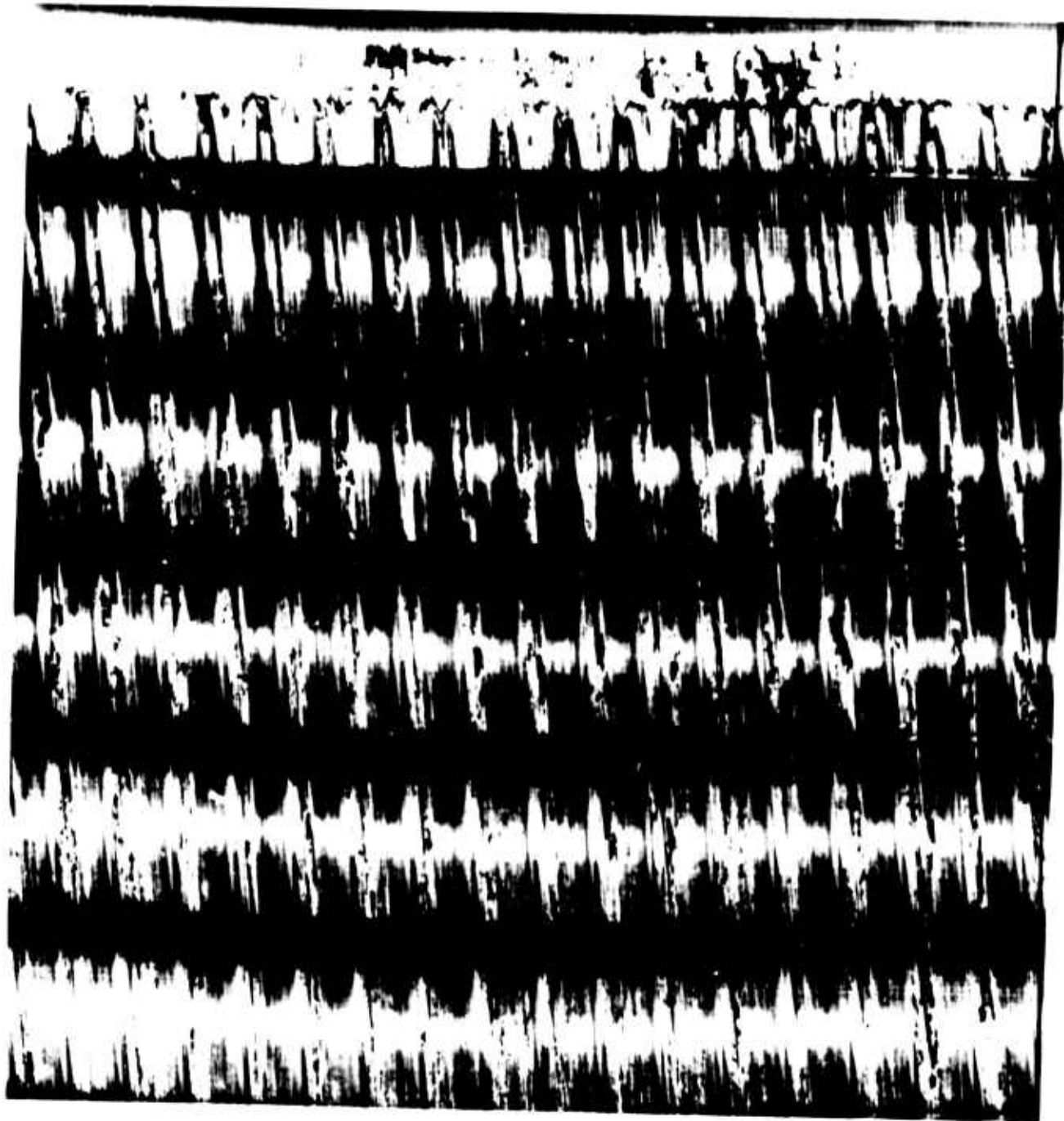
U.S. ARMY - SPRINGFIELD ARMORY

21 Dec 66

Standard M75 #F7791730 Ser #A58
Special Ammo: 40mm M385 (with orifice holes parallel to horizontal axis)
Lot PAE 54889
1,800 rds fired

32

PHOTOGRAPH 23



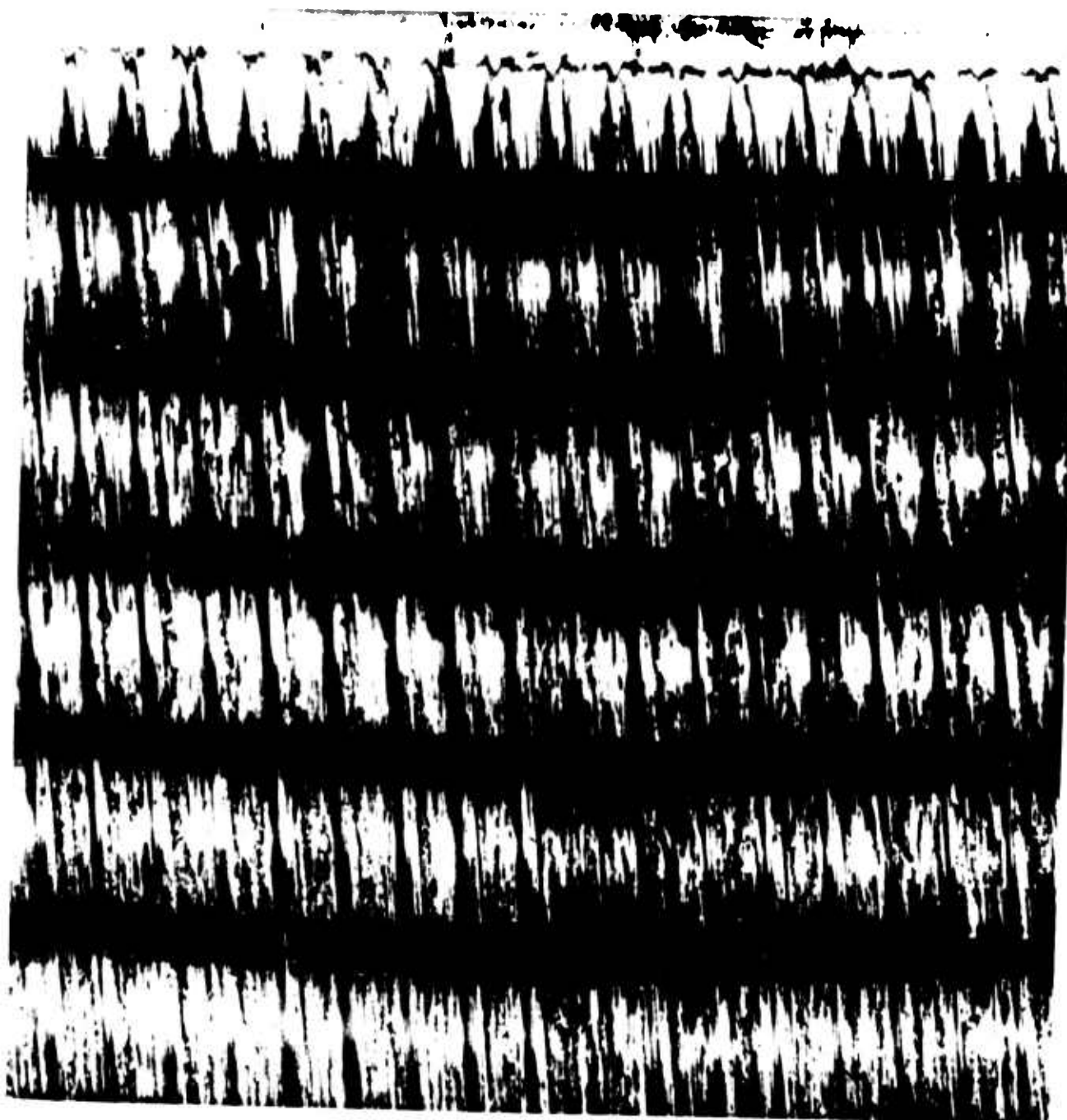
19-058-1088/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

21 Dec 66

Standard M75 #F7791730 Ser #A58
Special Ammo: 40mm M385 (with orifice holes parallel to horizontal axis)
Lot PAE 54889
3,613 rds fired

PHOTOGRAPH 24



19-058-1089/AMC-66

U.S. ARMY - SPRINGFIELD ARMORY

21 Dec 66

Standard M75 #F7791730 Ser #A58
Special Ammo: 40mm M385 (with orifice holes parallel to horizontal axis)
Lot PAE 54889
4,760 rds fired

51

PHOTOGRAPH 25



AS3434-563/MEC-65

JEFFERSON PROVING GROUND

2 November 1965

40mm M41 Barrel after 3500 rounds.

PHOTOGRAPH 26



A53434-564/ANC-65

40mm Mann Barrel after 5486 rounds.

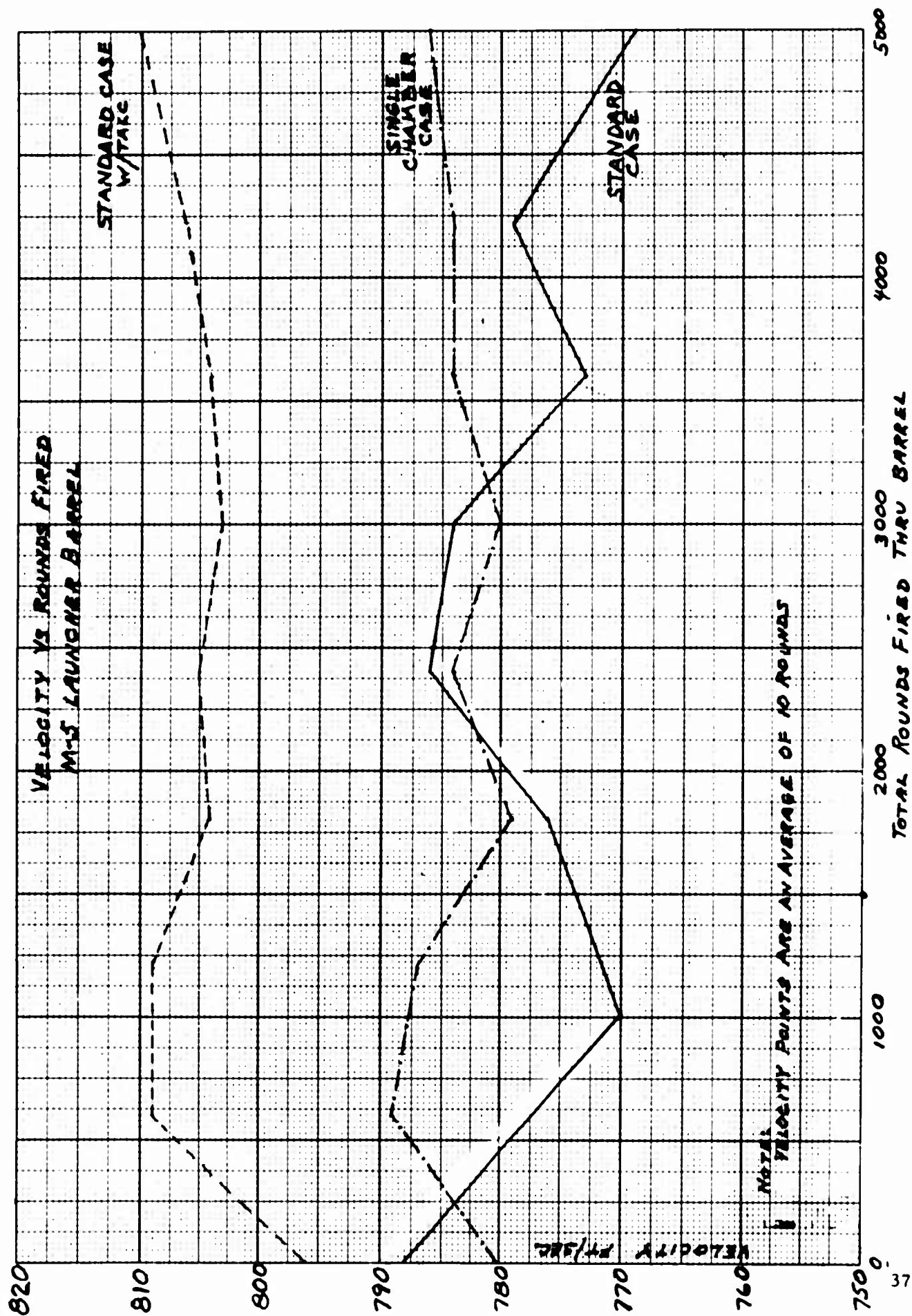
JEFFERSON PROVING GROUND

2 November 1965

PHOTOGRAPH 27

APPENDIX B

Velocity vs. Rounds Fired Chart



UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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d.			
10. DISTRIBUTION STATEMENT Statement 1 -- Distribution of this document is unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY Picatinny Arsenal U.S. Army Munitions Command Dover, New Jersey	
13. ABSTRACT The objective of this study by the Ammunition Engineering Directorate's Applications Engineering Laboratory was to determine the effect on the 40mm M75 Gun barrel wear using four different cartridge case systems (using the M169 Cartridge Case series). On the basis of test results, the present two-piece cartridge should be replaced with a single-chamber cartridge case. Although the two-piece cartridge case with talc additive produces results comparable with the single-chamber case, use of the single-chamber case would result in substantial cost savings as well as eliminating a source of system malfunctioning. This gun is part of the M5 Weapon System for Helicopters.			

DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
40mm munitions Gun barrel erosion study M169 Cartridge Case series M75 Gun Talc additive two-piece cartridge case single-chamber cartridge case Cost savings System malfunctioning elimination Excessive barrel wear Reduced barrel life Testing program Flash holes M5 Weapon System for helicopters						

UNCLASSIFIED

Security Classification